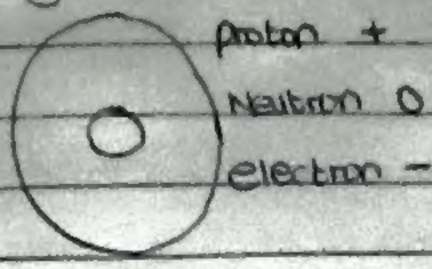
19/05/17 ELECTROSTATIC

There are two kind of Charges

+ positive charges

- Negative charges.



Electron Charges magnitude.

$3e = - - -$

$1e = 1.602 \times 10^{-19} C$

$3P = + + +$

$1P = +1.602 \times 10^{-19} C.$

A -ve charge & -ve charge will repel each other

A +ve charge & +ve charge will repel each other

A +ve & -ve will attract each other.

-The atom in it natural state is neutral.

The process of moving or removing an electron in an atom is called Ionization.

Na 11p 11electron => Na^+ 11p 10e.

Cl 17p 17e = Cl^- 17 18e.

Unit = Coloumb = C

$1C = 6$

$q = 1.60 \times 10^{-19}$

Object gas $= \frac{8.0 \times 10^{-19} C}{1.6 \times 10^{-19}} \simeq 5e$

The electrostatic force is an an binding force it binds. The proton & the electron

together & make them to Co-exist.

The Coloumbs law state the electric force btw two charge particle that are stationery is proportional to d product of d charge.

-> Coloumbs Law

$$F \propto \frac{q_1 q_2}{r^2}$$

NB:- 1st like charges repels while unlike charges attract. proportional to d product of d charge the force can be positive or negative

Q:- The electron & proton in an hydrogen atom are represented by

$r = 5.3 \times 10^{-19} m$.

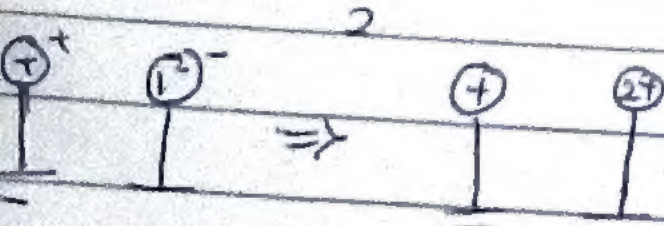
nd d magnitude of d force.

$q^+ \longrightarrow q^x$

$$= \frac{ke|q^+||q^-|}{r^2} = \frac{8.99 \times 10^{9}(1.60 \times 10^{-19})}{5.3 \times 10^{-11}}$$

$$= 8.2 \times 10^{-8} N.$$

$$3^+ + 1^- = \frac{3^+}{2}$$



$$4^+ + 1^- = \frac{3^+}{2}$$

ELECTROSTATICS

There are two kinds of electric charges, which were given the names positive & negatives.

• The charge on an atom is determined by a sub atomic particles that made up

proton: has a positive charge & it is located in d nucleus.
Neutron: has no charge (it's neutral) & it's also located in d nucleus as it fills d spaces btw d protons.
Electrons: has a negative charge & it is located outside of d nucleus in an electric cloud around d atom.

PARTICLE CHARGES.

Electron & proton have d same magnitude of charge (elementary charge e)

*Electron (-e): $-1.60 \times 10^{-19}C$

*Proton (+e): $+1.60 \times 10^{-19}C$.

*This is why electron are forced to orbit around d nucleus.

*Electrostatic forces hold atoms 2geda.

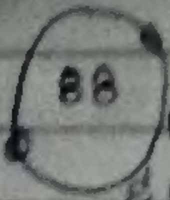
*The Law of charges which states dat like charge repel & unlike charges attract.

*A negatively charged rubber rod suspended by a thread is attracted to a positively charged glass rod.

A negatively charged rubber rod is repelled by another negatively charged rubber rod.

How do atoms become "Charged"?

*How can this happen?

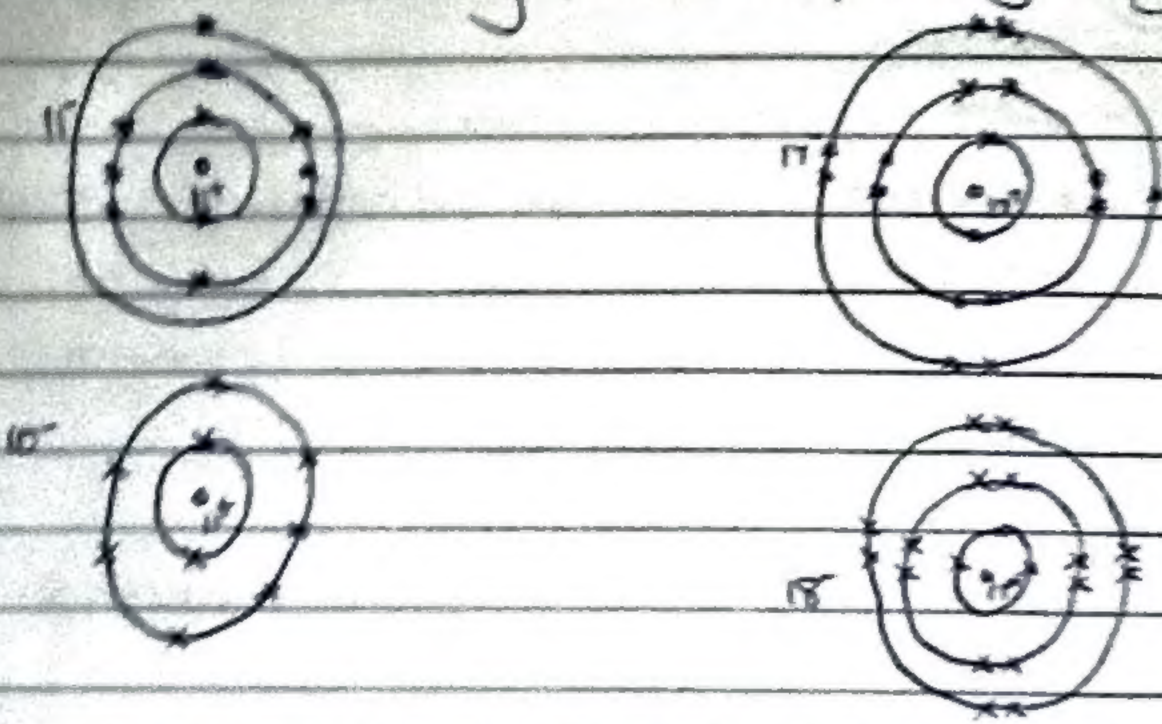


Remove or add a proton or an electron.

Protons & neutrons are bound together by a strong nuclear force & it is very hard to separate them. Electrons however can be more easily removed.

Ions:

An atom with a deficiency of electrons is positively charged.



An atom with an excess of electrons is negatively charged.

NOTE!!! ATOMS DO NOT GAIN OR LOSE PROTONS.

CHARGE IS A FUNDAMENTAL QUALITY LIKE MASS.

*Charge is denoted as q.

*Charge has a fundamental unit of a Coulomb (C).

*Charge are usually really really small numbers (10^{-19}).

*So what is 1C?

*An object would have to have 6.25×10^{13} extra electrons in amount to 1 C of charge.

• A lightning bolt is estimated to carry a charge of 10C.
• Revisit the charges on an electron & proton.

CHARGES ARE QUANTIZED, CAN ONLY BE IN MULTIPLES OF e

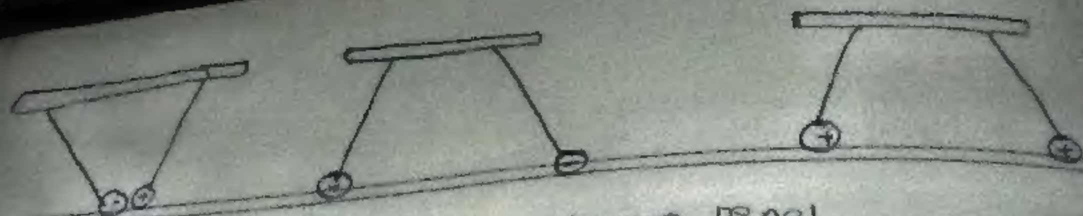
Remember :- • $-e$ = an electron = -1.60×10^{-19}C.
$+e$ = a proton = $+1.60 \times 10^{-19}$C.

• An object that has a net charge of 8.0×10^{-19}C has a net charge of what multiple of e? Hint: How many electron would need to be removed to create this charge?
The net charge would be $+5e$, 5 electrons were removed.
• Two kinds of charges occur in nature, with d property dat unlike charges attract one another & like charges repel one another.
• Charge is conserved.
• Charge is quantized.

MULTIPLES OF CHARGES CHART.

1e	1.6×10^{-19}
2e	3.2×10^{-19}
3e	4.8×10^{-19}
4e	6.4×10^{-19}
5e	8.0×10^{-19}

ELETROSTATIC FORCE.
This is a non-contact force like d gravitational force except instead of two masses exerting force on each other the two objects charges exert a force of repulsion or attraction.
• Any charged object can exert the electrostatic force upon other objects - both charged & uncharged object.



COLOUMB'S LAW.

Coloumb confirmed dat d electric force btw two small charged sphe... proportional to d inverse square of their separation distance.

Coloumb's Experiments showed that the electric force between two stationary charged particles:

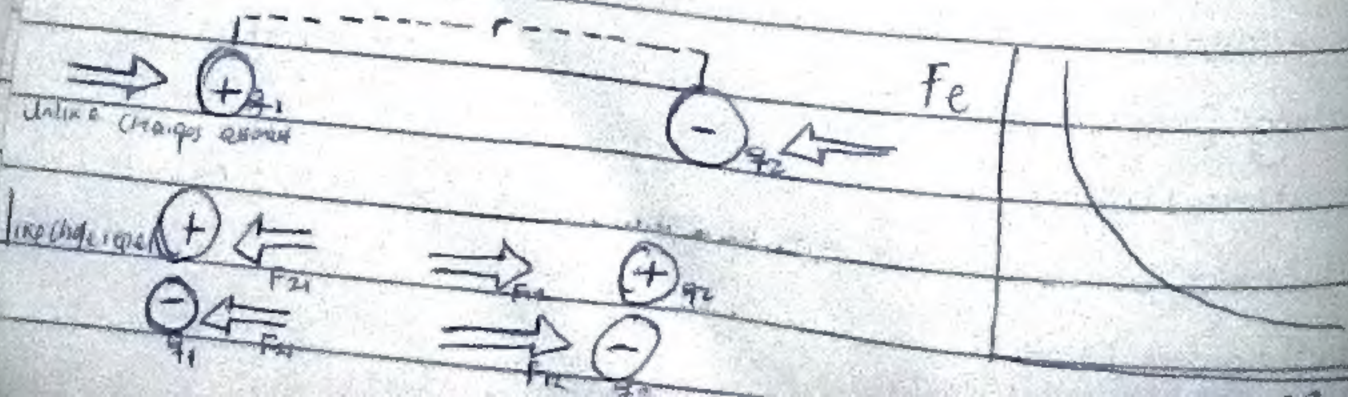
- Is inversely proportional to the square of the separation between particles and directed along the line joining them.
- Is proportional to the product of the charges q_1 and q_2 on the two particles;
- Is attractive if the charges are of opposite sign and repulsive if the charges have the same sign.

From these observation, we can express Coloumb's Law equation the magnitude of the electric force (sometimes called the Coloumb force) between two point charges.

$$F_e = k_e \frac{|q_1||q_2|}{r^2} \qquad k_e = 1/4\pi\epsilon_0$$

Where k_e is a constant called constant $k_e = 8.9275 \times 10^9 \, N\cdot m^2/C^2$

THE ELECTROSTATICS FORCE



Magnitude

$$F_e = \frac{K_e |e|^2}{r^2} = \left(8.99 \times 10^9 \ \frac{N \cdot m^2}{C^2}\right) \left(\frac{1.60 \times 10^{-19} C^2}{5.3 \times 10^{-11} m}\right)$$

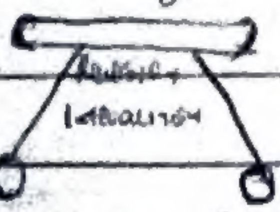
$$= 8.2 \times 10^{-8} N.$$

Example of electrostatic) forces

will have a attractive interaction with a nuetral Object

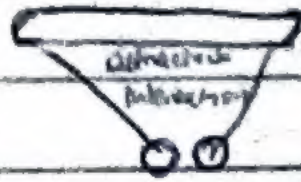
- A ballon when rubbed on your head become charged by Picking up extra electrons from your hair
- The Same balloon, because it is charged, will attract a nuetral Object like Pieces of Paper

So we are able to Predict the Charge on Object based on their Interaction with other Object.



Repulsive interaction Provide convincing evidence that both Object Must be charged

They can either both be positive or both be negative.

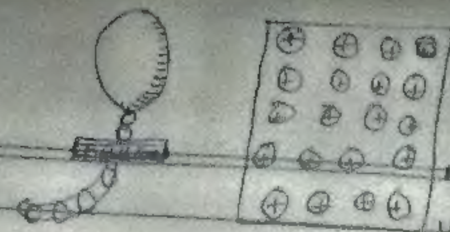


Attraction interaction can lead one to conclu[de] that a Least one of the Object is charged.

They can have opposite Charges or one Object is charged and the other is nuetral.

Why does the ballon Stick to the wall.

- When a ballon is rubbed with a Piece of cloth, electrons are transferred b[...]



NOTE: The [illegible] wall is not in scale with the balloon

WHAT HAPPEN TO YOUR HAIR WHEN YOUR RUB A BALLOON ON YOUR HEAD?

• The balloon, after being rubbed and then pulled away, removes some of the electrons in your hair which give each strand a positive charge. Like charges want to repel and each strand is repelling from the others and "Standing up".

GETTING SHOCKED.

• As you walk across a carpet, electrons are transferred from the rug to
• Now you have extra electrons.
• Tough a door knob (conductor) and ZAP!
• The electrons move from you to the knob.

LIGHTNING

• Lightning is a really big shock.
• Positive charges tend to go up, negatively charges tend to go down.
• When the attraction reaches a critical level you get a Lightning bolt.

OBJECT that tend to give up Electrons and become ~~negative~~ Positive

* Glass * Fur * Wool
* NYLON * Hair

OBJECT that tend to attract electron and become negative.

* Rubber * Styrofoam * PVC
* Polyester * Saran wrap

INSULATORS AND CONDUCTORS.

Different Materials hold electrons differently.

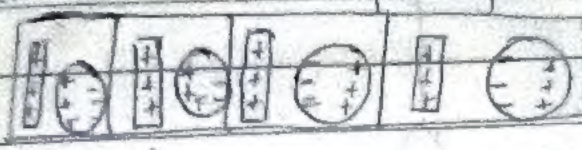
• INSULATORS don't Let electron move arond ~~around~~ within material ~~[illegible]~~ freely.

~~Eg. Glass, Plastics, Glass, Dry air, wood, Rubber~~

Conductor:- de the electron move around within the material freely e.g metals, Silver, copper, Aluminium.

TRY THIS

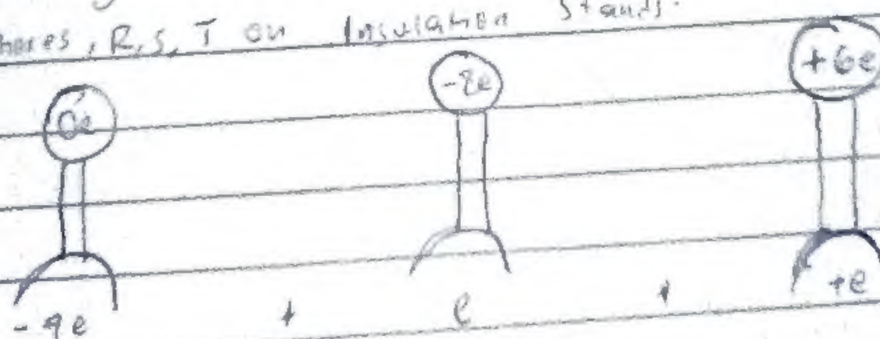
- A charged plastics rod is brought close a neutral metal sphere how would the distribution of charges be in the metal sphere?
- Which of the diagram below best represents the charged distribution on a metal sphere when a positively charged plastic tube is placed nearby?



LAW OF CONSERVATION OF CHARGE

- Charges within a closed system may be transferred from one object to another, but charge is neither created nor destroyed.

The diagram below shows the initial charges and positions of three metal spheres, R, S, T on insulation stands.

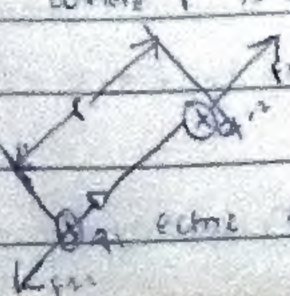


Note that the net charge on the system is -2e

= -2e

Electrostatic FORCE IS A VECTOR QUANTITY.

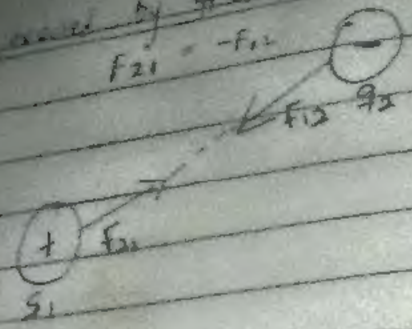
Thus the Columb is Law Expressed in vector from for the electric force exerted by a charge q_1 on a second charged q_2, written F_{12} is where $\hat{r}$ is a unit vector directed from q_1 to q_2



Because the electric force obeys Newton third Laws the magnitude to the electric force exerted by q_2 on q_1 is equal to magnitude to the

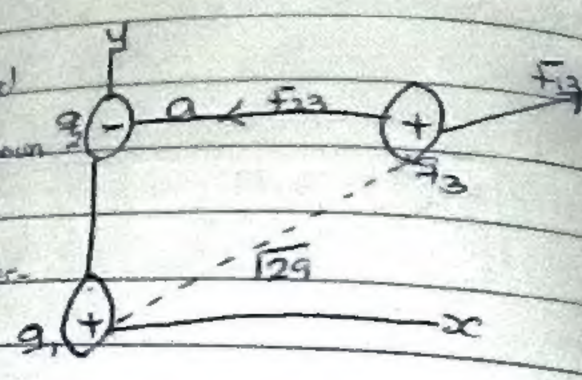
Force exerted by q_2 on q_1 and in the opposite direction; ...

$$F_{21} = -F_{12}$$



Example:-

Consider three point charges located at the corner of a right triangle as shown where $q_1 = q_3 = 5.0\,\mu C$, $q_2 = -2.0\,\mu C$ & $a = 0.10\,m$. Find the resultant force exerted on q_3.



The magnitude of F_{23} is

$$F_{23} = k_e \frac{|q_2||q_3|}{a^2} = \left(8.99 \times 10^9 \frac{N \cdot m^2}{C^2}\right)\left(\frac{2.0 \times 10^{-6} C \times 5.0 \times 10^{-6} C}{(0.10 m)^2}\right)$$

The magnitude of the force exerted by q_1 on q_3 is

$$F_{13} = k_e \frac{|q_1||q_3|}{(\sqrt{2}a)^2}$$

$$= \left(8.99 \times 10^9 \frac{N \cdot m^2}{C^2}\right)\left(\frac{(5.0 \times 10^{-6} C)(5.0 \times 10^{-6} C)}{2(0.10 m)^2}\right)$$

$$= 11 N.$$

The force F_{13} is repulsive & makes an angle of 45° with the x axis. Therefore the x & y component of F_{13} are equal with magnitude given by $F_{13} \cos 45° = 7.9 N$.

The force F_{23} is in the negative x direction. Hence the x & y components of

d resultant force acting on q_3 are:-

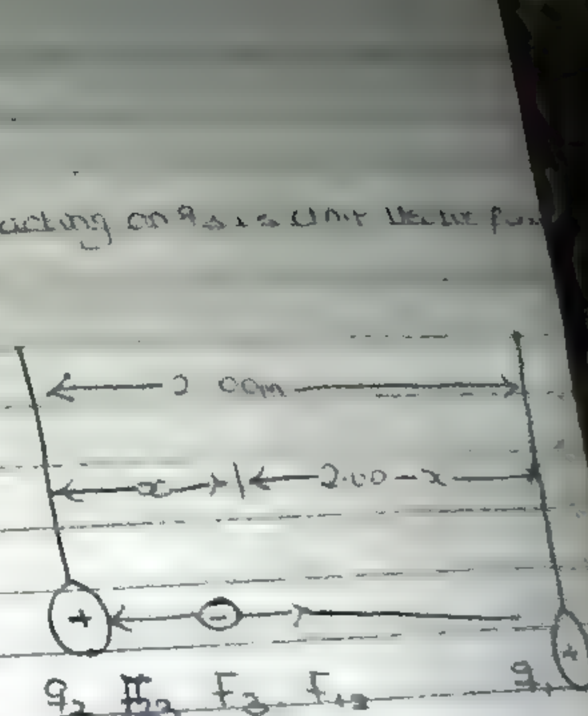
$F_{3x} = F_{13x} + F_{23x} = 7.9N - 9.0N = -1.1N$.

$F_{3y} = F_{13y} = 7.9N$.

We can also express d resulting force acting on q_3 in unit vector form as: $F_3 = (-1.1i + 7.9j)N$.

Example:-

Three point charges lie along d x-axis. The positive charge $q_1 = 15.0\mu C$ is at $x = 2.00$. The positive charge $q_2 = 6.00\mu C$ is at d origin. & d resultant force acting on q_3 is zero. What is d x co-ordinate of q_3?



Solution.

Bcos q_3 is negative & q_1 & q_2 are positive, d force F_{13} & F_{23} are both attractive, from Colomb b/w F_{13} & F_{23} have magnitude:

$$F_{13} = ke\frac{|q_1||q_3|}{(2.00-x)^2} = F_{23} = ke\frac{|q_2||q_3|}{x^2}$$

For d resulting force on q_3 to be zero

e.g: The electron & proton in an hydrogen atom are represented.

$r = 5.3 \times 10^{-19}M$.

Find d magnitude of d force:

$q^+ \rightarrow q^-$.

$$F = ke\frac{|q^+||q^-|}{r^2} = \frac{8.99\times10^{-9}(1.60\times10^{-19})}{5.3\times10^{-11}}$$

$$= 8.2\times10^{-8}N.$$

31/7/17 — Electric field of force :

Electric field & force :

Electric dipoles.

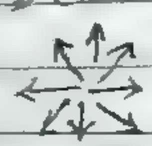
Charge particle in E in upper poles :

Electric field region whose electric force is expressed as:-

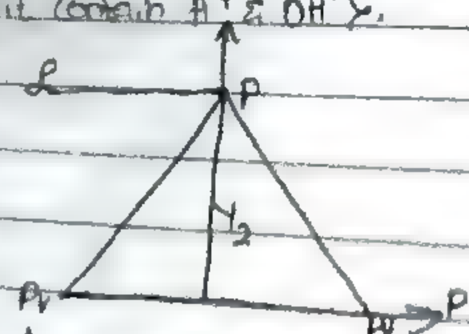
$$E = \frac{1}{4\pi\varepsilon} = \frac{\varepsilon q r}{\varepsilon}$$

$$E = \frac{F}{q}$$

i.e. is of electric field ε



a Electric dipoles:- 2 diff poles carrying different charges eg water molecules b/cos it contain H^+ & OH^-).



a) Along of axis of dipoles.

b) perpendicular to d axis.

Motion of charge particle in ε

$$q\varepsilon = ma$$

$$a = \frac{q}{m}\varepsilon$$

11/07/21: "Charge & electric flux:

→ Gauss law & its application:

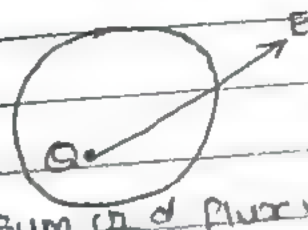
* Charge & electric flux

The total of the electric flux out of a ~~float~~ close surface is equal to the charge enclosed divided by the permitivity. The flux 2ru an area is $\Delta\Phi = E\Delta A$ <$\Delta\Phi$ change in flux; ΔA change in area>

Diagram:-

E ⊥ surface area.

$$\text{<flux>}\ \Phi = \frac{Q\ \text{<charge>}}{\varepsilon_0\ \text{<permitivity>}}$$



The sum of d flux is proportional 2 d total charge enclosed. The electric flux 2ru an area is defined as d electric field multiplied by d area of d surface projected in a plane perpendicular 2 d field. "Guass law is general law applying 2 any close surface"

"Guass law integral;-

$$\oint \vec{E}\cdot d\vec{A} = \frac{Q}{\varepsilon_0}$$

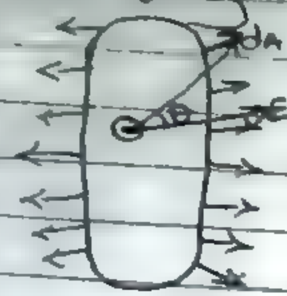
The area of d electric field over any closed surface is equal 2 d net charge enclosed in d surface divided by d permitivity of space. "Guass law is a form of one of Maxwell's equation, the four fundamental equation for electric & magnetism.

ELECTRIC FLUX.

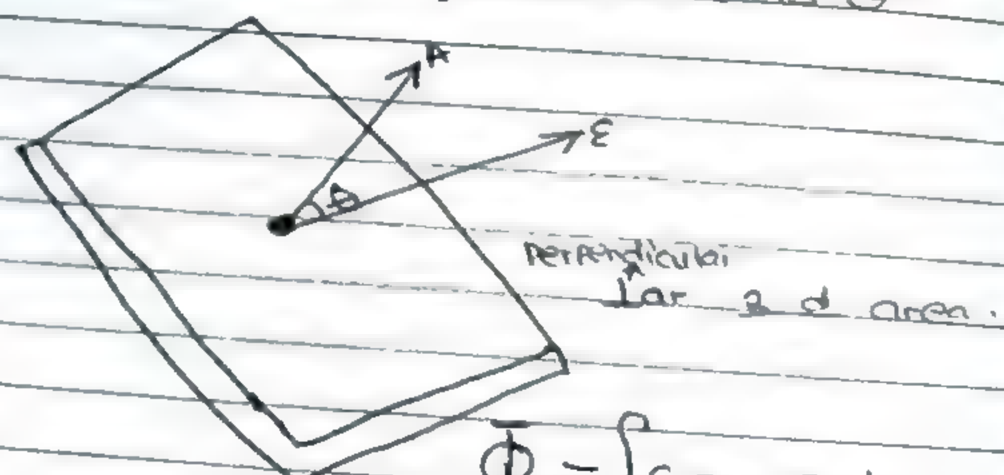
The concept of electric flux is useful in association with Gauss [illegible] electric flux thru a planar is defined as the electric field [illegible] component of d area perpendicular 2 d field. If d area is not p[illegible] then d evaluation of d flux generally requires an area integ[illegible] since d angle will be continually changing.

$$\text{Flux} = \Phi = E_A \cos\theta.$$

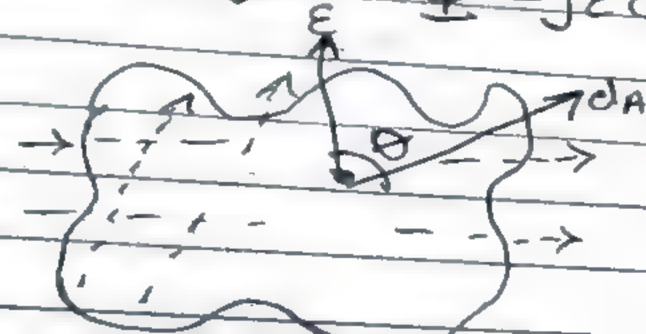
Relative permittivity $= \varepsilon_r = \frac{\varepsilon}{\varepsilon_0}$



The angle btw d electric field & d area is θ.



$$\Phi = \int E \cos\theta \, dA.$$



* $10^{-12} \rightarrow$ pico.

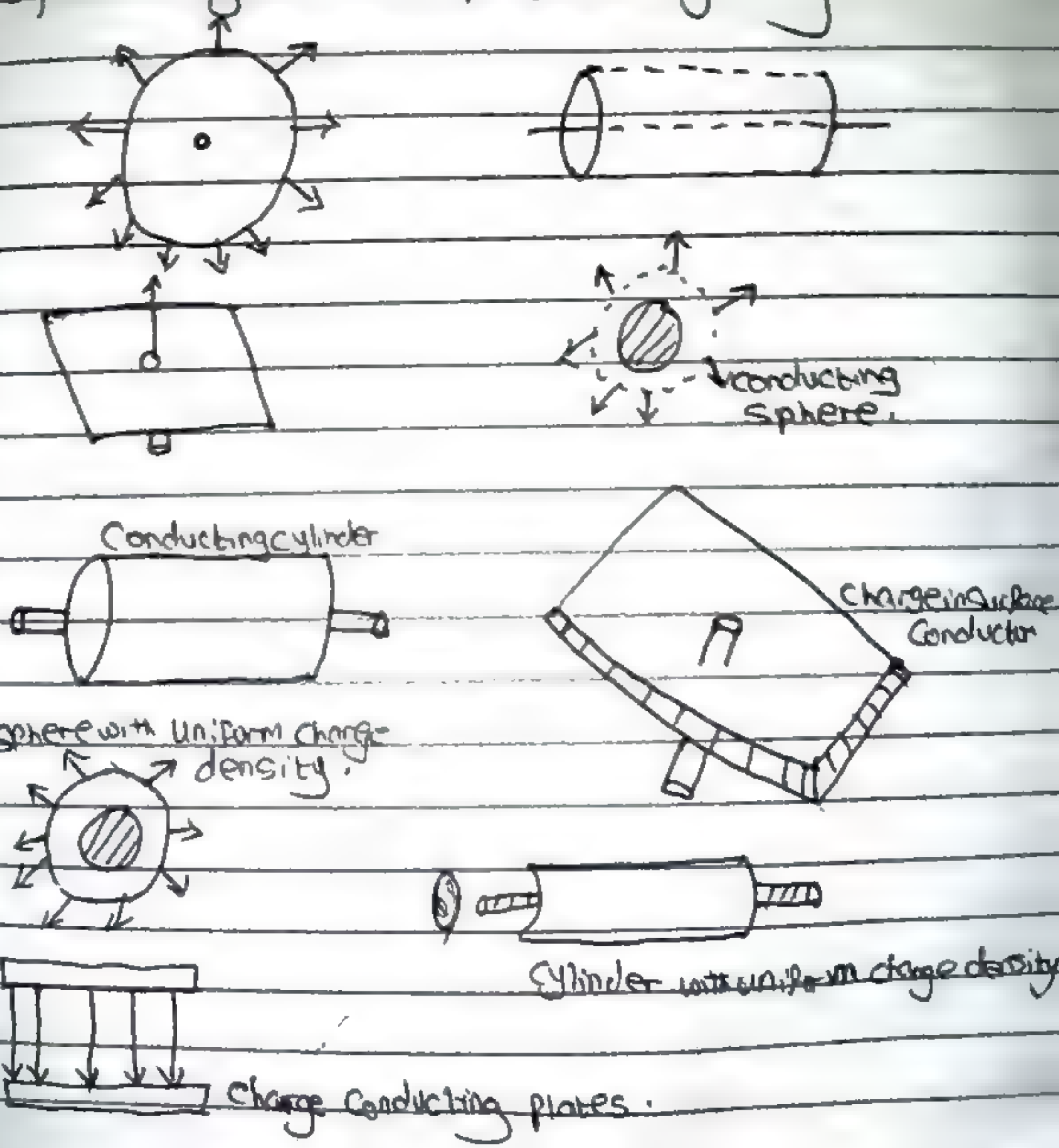
When d area A is used in a vector operation like this, it is understood dat d magnitude of d vector is equal 2 d area & d direction of d vector is perpendicular 2 d area.

ε_r = permitivity of a medium & dielectric.

$\varepsilon_0 = 8.85 \times 10^{-12}$ F/m

Application of Guass law.

It is a powerful tool for Calculation of electric field when they originate from Charge distribution of sufficient symmetry.



ASS

Write four maxwell's equation:

Solution:

Maxwell's Equation are:- i) Guass law.

ii) Faraday's law.

iii) Electro magnetic induction law

iv) Ampere's law.

Ar. Hammed olaide Sakiruden

181021

ELECTRIC POTENTIAL:

Electric potential means taking the potential in a charge from a particular point 2 another within an Electric Circuit.

$$F = QE$$

$$\therefore E = F/Q$$

$$\Delta V = \Delta U/Q$$

where, Q = charge.

U = Change in electric potential energy.

V = Change in electric potential.

Equipotential Surfaces :- It is a set of point where the electric potential energy as given in the value.

* Find E from V

$$E_x = \frac{-\Delta V}{\Delta x}, \quad E_y = \frac{\Delta V}{\Delta y}, \quad E_z = \frac{\Delta V}{\Delta z}$$

potentential of a point charge & Groups of point charges

* When is [illegible] electric potential [illegible]

$V = \frac{1}{r}$

potential due to a continuous charge distribution

potential energy of system of charges

problems

1. The electric potential difference b/w the ground & a cloud in a particular thunderstorm is $1.2 \times 10^9 V$. What is the magnitude of the change in energy (in multiples of the electron volt).

Soln.

$$\Delta V = \frac{\Delta U}{q}$$

$$\Delta U = q \times \Delta V$$

$$= 1.6 \times 10^{-19} \times 1.2 \times 10^9 V$$

$$= 1.2 \times 10^9 eV.$$

2. An infinite non conducting sheet has a surface charge density σ = 0.10 $\mu C/m^2$ on one side. How far apart are equipotential surface whose potential differ by 5[illegible]?

3. Two large parallel conducting plates are 10cm apart & have charges of equal magnitude & opposite sign on their facing surface. An electrostatic force of 3.9×10^{-12} act on an electron.

The electron potential at a point in a plate is given by $V = 2x^2 - 3y$ [illegible]. What are the magnitude & direction of the electric field at the point

[illegible]

differentiate $(2x^2 - 3y^2)$

$= 2\times 2x^{2-1} - 2\times 3y^{2-1}$ ... (1) (2)

$= 4x - 6y$ ... $4x - 6y$

$E = \frac{\Delta V}{?}$

where $x = 3$ & $y = 2$

$= 4(3) - 6(2)$

$= 12 - 12 = 0$

magnitude $E = \sqrt{12^2 + (-12)^2}$

$= \sqrt{144 + 144}$

$= \sqrt{288}$

25/04/17: CONDUCTORS & CURRENT & ELECTRIC CURRENT, RESISTORS & RESISTANCE ELECTRIC POWER.

Electric current is d quantity of charges that flow in a wire or in a conductor or in a circuit per second.

Conductor allows electric current to pass through them easily.

Insulator doesn't allow electric current to pass through them.

The gap btw valence gap & the conductor gap is called energy gap.

CB

→ energy gap.

VB

Super conductor offer no resistance to the flow of current & the resistance is zero out.

electric current $= i = \frac{q(c)}{t(s)}$

$q = it$

electric current is measured in ampere.

Unit of current $i(A) = \frac{C}{S}$

$1\ ampere = 10^{-6}\,\mu A \,/\, 10^{-3}\,mA$

$i = \frac{dq}{dt}$

$dq = i\,dt$

$q = \int_0 i\,dt$

Current density is the quantity of charge per unit area. That passes

$$j = \frac{I}{area}\left(\frac{A}{m^2}\right)$$

*Lighter object has high density than heavier object.

Resistivity is define as the ratio of electric field per current density. $\rho = \frac{E\ (Electric\ field)}{J\ (current\ density)}$

$$= \frac{\frac{V}{L}}{\frac{I}{A}} = \frac{V}{L} = \frac{A}{I}$$

$$\text{Slope} = \frac{\Delta V}{\Delta I} = \rho$$

$V \propto I$

$V = IR$

$\rho = \frac{RA}{L}$

Resistance $= R \propto L$

$\therefore \rho \propto \frac{1}{A}$

$R \propto \frac{1}{A}$

$R = \frac{\rho L}{A}$

$\therefore \rho = \frac{RA}{L}$

Conductivity:-

$$\sigma = \frac{1}{\rho} \quad (\Omega^{-1} m^{-1}) \text{ unit}$$

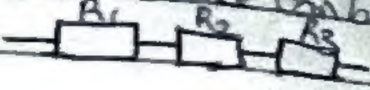
$$\rho = \frac{\vec{E}}{J}$$

$$\frac{1}{\sigma} = \frac{\vec{E}}{J}$$

$$\Rightarrow J = \sigma \vec{E}$$

* Fixed resistor are resistor with whole no value. e.g 1, 2, 3, 4, 5 ...etc
* Variable resistor are resistor in which resistance can be varied.

-> Arrangement of resistors: series &

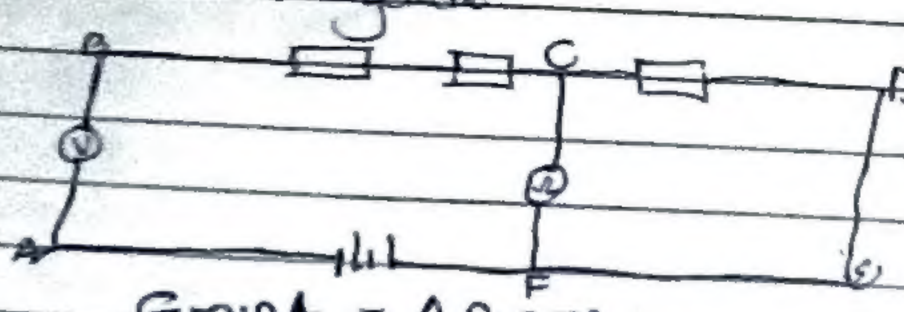


parallel.

$I_o = i_1 + i_2 + i_3$

or $I_o - i_1 - i_2 - i_3 = 0$

series arrangement:



Group 1 = ABCFA

Group 2 = CDEFC

Group 3 = ABCDEF

$V_1 = IR_1$

$V_2 = IR_2$

$V_3 = IR_3$

$V = V_1 + V_2 + V_3$

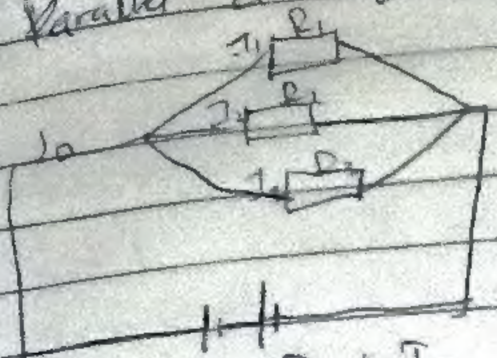
$IR = IR_1 + IR_2 + IR_3$

$IR = I(R_1 + R_2 + R_3)$.

Combine resistance, equivalent resistance or total Resistance.

$$R_T = R_1 + R_2 + R_3.$$

Parallel arrangement of resistors



$I_0 = I_1 + I_2 + I_3$

$V = IR_T \Rightarrow I = \frac{V}{R_T}$

$V = I_1R_1 \Rightarrow I_1 = \frac{V}{R_1}$

$V = I_2R_2 \Rightarrow I_2 = \frac{V}{R_2}$

$V = I_3R_3 \Rightarrow I_3 = \frac{V}{R_3}$

$V = IR$

$I = \frac{V}{R}$

$$\frac{V}{R_T} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$\cancel{V}\left(\frac{1}{R_T}\right) = \cancel{V}\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

*Electric Conductance

Joules law of electric Current

$H \propto I^2$

$H \propto R$ $\qquad H = I^2Rt$

Power $= IV = I(IR) = I^2R$

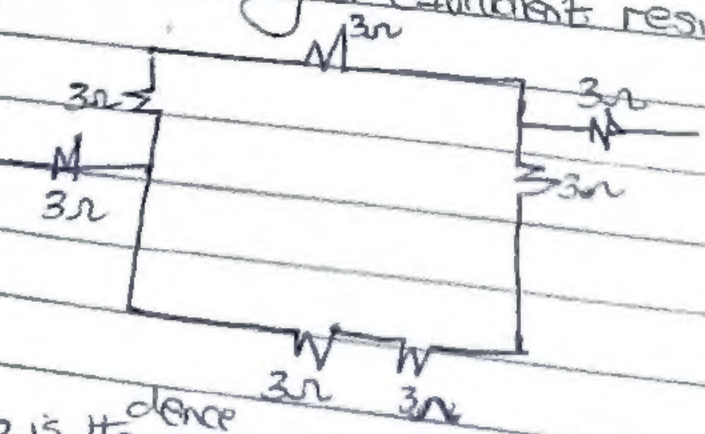
$P = IV$

$I = \frac{V}{R} = \frac{V}{R} \times V = \frac{V^2}{R}$

Example 1. A square block of alloy has dimension 1.5cm by 1.5cm by 1.5cm by 1.5cm. A potential difference is to be applied between the alloy block and a ________, So that both size are equipotential surfaces, take resistivity to be $9.6 \times 10^{-6}\,\Omega m$.

2. The resistivity of a broken piece of broken wire of length 30m is 5.4 $\times 10^{-7}\,\Omega m$, If the cross sectional area of the wire is $9.5 \times 10^{-7}\,m^3$, Cal. the resistance of the wire.

3. A determined resistivity or equivalent resistance of the circuit below



R_2 is ~~the same~~ dence with R_3.

$R_{11} = 3\Omega + 3\Omega = 6\Omega$

R_4, R_5 & R_6 are indence.

$R_{12} = R_4 + R_5 + R_6$

$= 3\Omega + 3\Omega + 3\Omega = 9\Omega$.

$\therefore R_{11} // R_{12}$

$= \frac{1}{R_{12}} = \frac{1}{R_{11}} + \frac{1}{R_{12}} = \frac{1}{6} + \frac{1}{9}$

$= \frac{3+2}{18} = \frac{5}{18}$